NPS I&M Program: Overview and Opportunities to use Remotely Sensed Data

John Gross
NPS Monitoring Program
Ft. Collins, Colorado

St Petersburg, Florida
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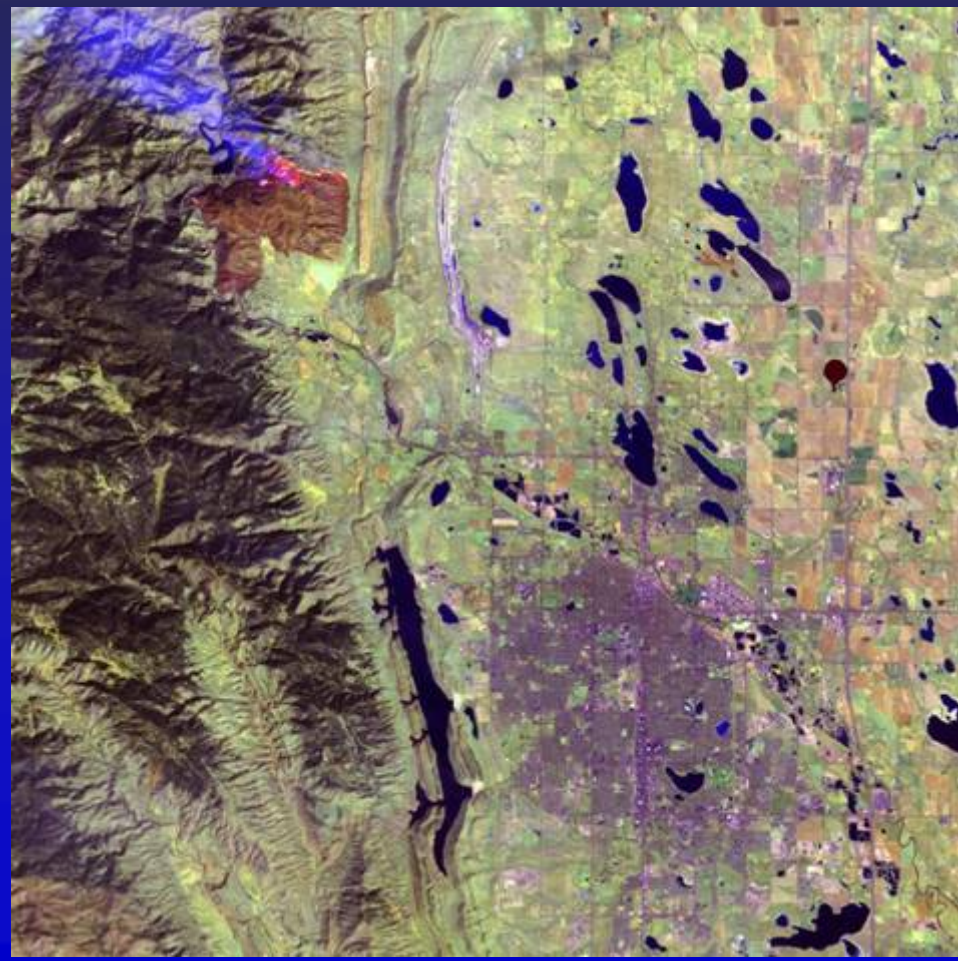


Picnic Rock Fire 2004, near Ft. Collins


• Overview of NPS Inventory and Monitoring Program
• Vital signs framework and RS-related priorities
• Pattern and process
• NPS RS projects and resources

Natural Resource Challenge

Revitalize and expand the natural resource program within the NPS service and improve park management through greater reliance on scientific knowledge.

NPS Natural Resource Challenge

- Provides funding and new positions for natural resource stewardship to add to NPS visitor services capability
- Learn what is in parks (inventories), and monitor the vital signs of natural systems
- Engage the scientific community and the public, and facilitate their inquiries
- Share the information widely

Overall Purpose of Monitoring:

Determine trends in the condition of selected park resources

- Assess the efficacy of management and restoration efforts;
- Provide early warning of impending threats;
- Provide a basis for understanding and identifying *meaningful change* in natural systems characterized by complexity, variability, and surprises.

Vital Signs Monitoring – 3 Characteristics

1. **Long-term, ecological monitoring perspective**
2. **Integration and coordination among parks, programs and agencies**
3. **Emphasis on information management**

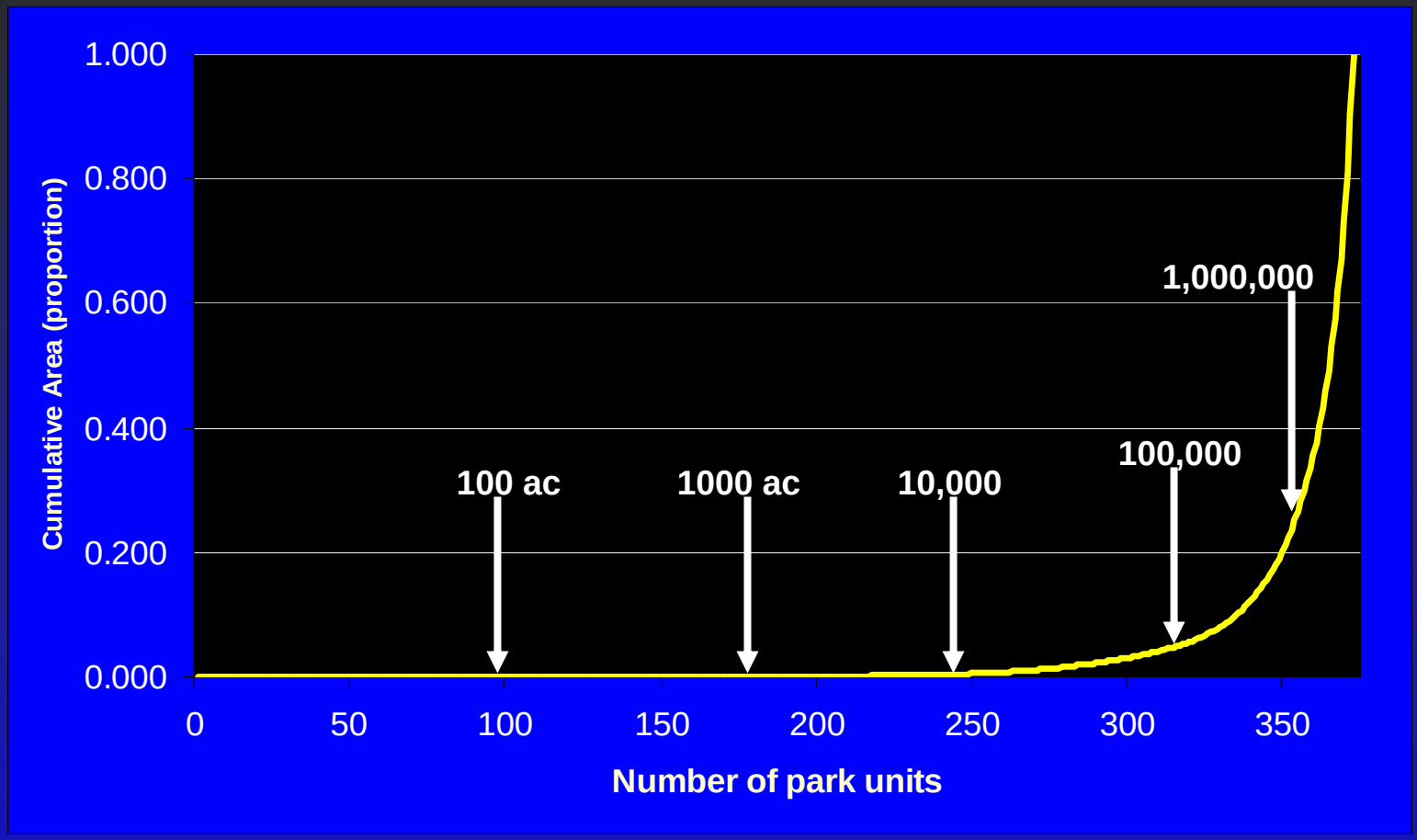
Economics 101

I&M Programmatic funding would allow each park to add one professional position plus ~ $30-40 K operating

Conclusions/Strategy:

- Must integrate, embellish, and cost-sharing to implement a systematic monitoring program;
- Park buy-in and cost-leveraging through partnerships are critical; must be relevant to park managers and flexible to facilitate integration and partnerships;
- Establish 32 “monitoring networks” that share funding and staffing among parks to gain efficiencies and consistency.

About 270 Parks with natural resources

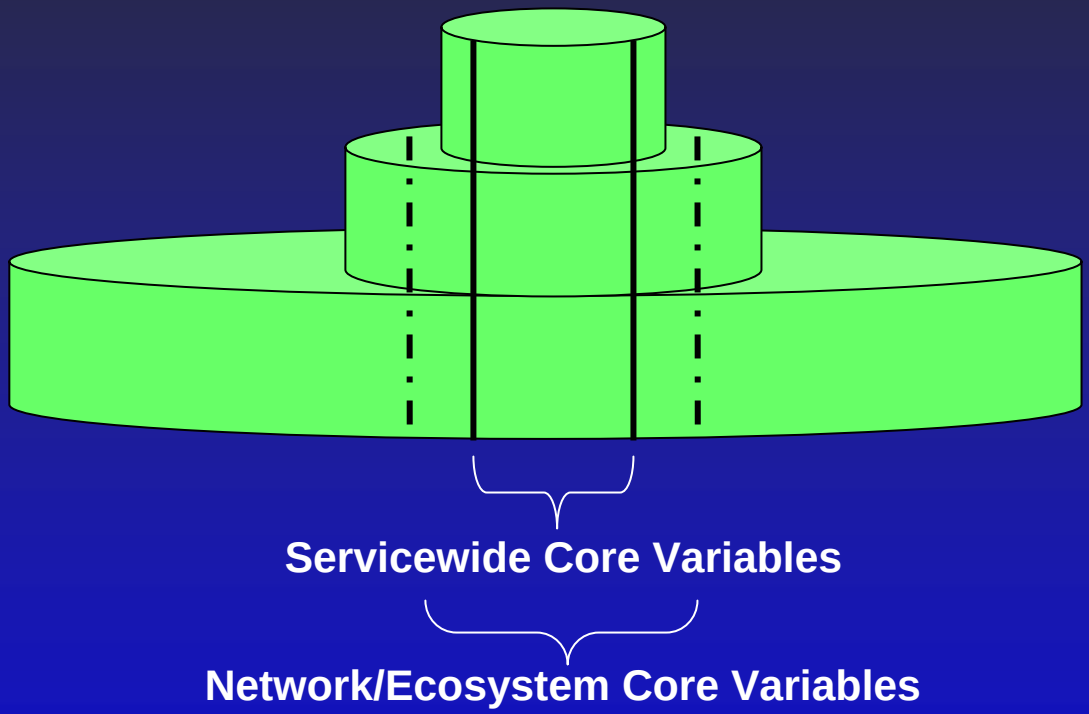


50% of parks < 1500 ac (607 ha)

65% of parks are < 10,000 ac (4,050 ha)

The Wedding Cake

An alternative to “One Size Fits All”



National

Network/Ecosystem

Park

- **Primary use of data is at the local level**
- **Most relevant indicators and protocols differ between systems**

Vital Signs Framework (abbreviated)

Level 1 Category	Level 2 Category
Air and Climate	Air Quality
	Weather and Climate
Geology and Soils	Geomorphology
	Subsurface Geologic Processes
	Soil Function and Dynamics
Water	Hydrology
	Water Quality
Biological Integrity	Invasive Species
	Infestations and Disease
	Focal Species or Communities
	At-risk Biota
Human use	Point-Source Human Effects
	Non-point Source Human Effects
	Consumptive Use
	Visitor and Recreation Use
	Cultural Landscapes
Ecosystem Pattern and Processes	Fire
	Land Cover and Use
	Extreme Disturbance Events
	Soundscape
	Nutrient Dynamics
	Productivity

More complete framework is in handout.

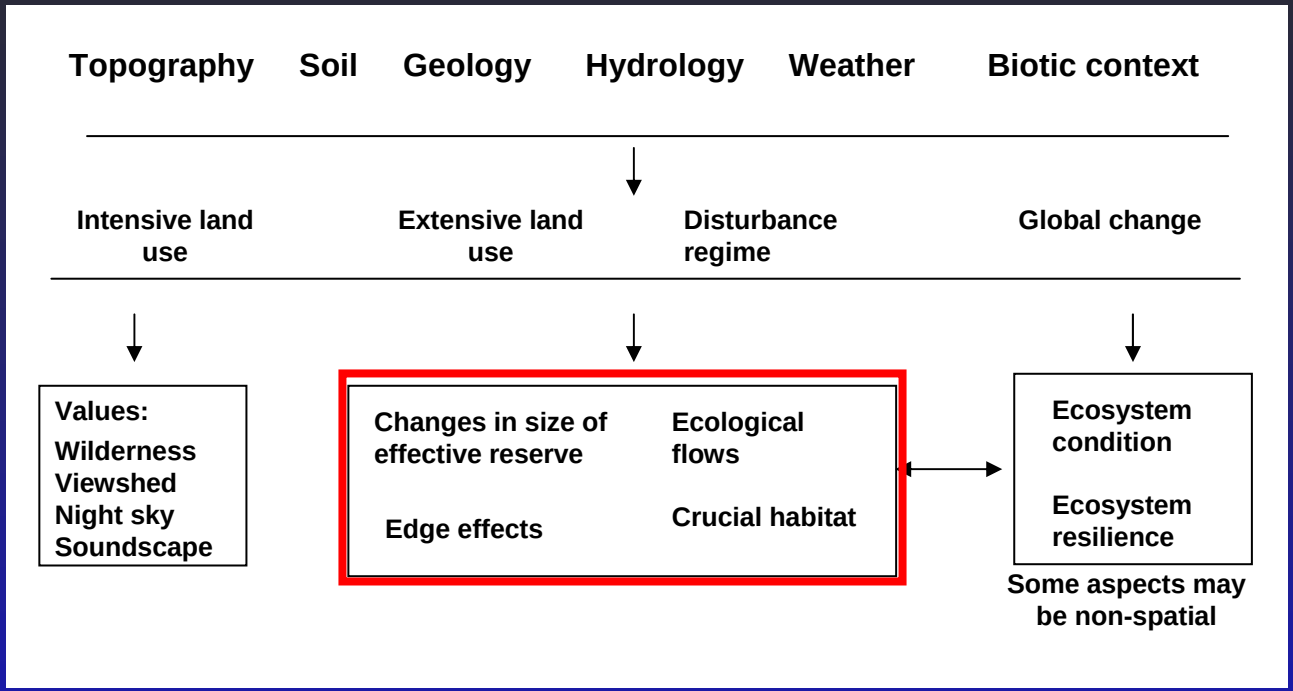
Most Common Vital Signs (first 17 networks)

Vital Sign	Example Measures (varies by network)	# Networks/ Parks
Land Cover and Use	Area in each land cover and use type; patch size and pattern (from satellite and aerial imagery), major disturbancs	17 / 137
Water Chemistry	pH, temperature, dissolved oxygen, conductivity	17 / 136
Weather and Climate	Temperature, precipitation, wind speed, ice on/off	17 / 125
Invasive / Exotic Plants	Early detection (predictive search models); presence/absence, area covered by exotic species	12 / 115
Surface Water Dynamics	Discharge/flow rates (cfs), guage/stage height, lake elevation, spring/seep volume, sea level rise	13 / 95
Birds	Species composition, distribution, abundance	14 / 82
Ozone	Atmospheric ozone concentration, damage to sensitive vegetation	12 / 68
Soil Function and Dynamics	Biological soil crusts, aggregate stability, soil surface condition, nutrients, organic matter	8 / 59
Wet and Dry Deposition	Wet deposition chemistry (pH, NO3-, SO4=), continuous sulfur (SO2) dioxide concentrations	12 / 58
Visitor Usage	Number of visitors by location, activity, season	8 / 58
Stream Channel Characteristics	Erosion/sedimentation, channel change, rate of scouring, stream profiles, coarse woody debris	6 / 57
Aquatic Macroinvertebrates	Species richness, diversity, IBI of stream macroinvertebrates, relative abundance	10 / 56
Vegetation Communities	Species richness and diversity, rates of mortality and regeneration, stand structural dynamics	9 / 55
Visibility and Particulate Matter	IMPROVE network; visibility and fine particles	13 / 52

Network Name	Measures
Land cover, landscape pattern, habitat patch dynamics, etc.	Area of dominant land cover types, patch size distribution, connectedness, edge-to-area, fragmentation, etc.
Park insularization	Use of lands adjacent/near park boundaries. Road density, housing, light, patch size, viewshed composition, etc.
Land use patterns, land use, etc.	Road density, housing density, other development & resource extraction adjacent to parks, impervious surface, structures, etc.
Land condition; vegetation condition and disturbance pattern	Change in start of growing season, change in growing season, cumulative NDVI; frequency, severity, and extent of 'disturbance'
Insect damage	Presence of insect damage and defoliation, dead, stressed, or disease trees, intensity and rate of spread of pests
Plant phenology, snow pack extent, climate	Snow cover, onset/end of greenness, ice on/off, flowering, PAR, soil surface temperature, soil moisture

See Handout for additional details

Broad effects of land use and land cover change



Ecological Mechanisms Linking Parks to Land Use Change

Mechanism	Type of effect
Change in effective size of reserve	Species area effect Minimum dynamic area Tropic structure
Changes in ecological flows into and out of reserve	Disturbance initiation and runout zones Placement in watershed or airshed
Loss of crucial habitat outside of reserve	Ephemeral habitats Dispersal or migration habitats Population source / sink habitats
Increased exposure at reserve edges	Poaching Displacement Exotics / disease

(modified from Hansen and DeFries in prep)

Ecological Mechanisms Linking Parks to Land Use Change

Mechanism	Type of effect	**Monitoring**
Change in effective size of reserve	Species area effect	**Land use and habitat area**
	Minimum dynamic area	**Disturbance patterns**
	Tropic structure	**Wildlife populations**

(modified from Hansen and DeFries in prep)

Public data sources that can support monitoring

Spatial Dataset	*Source*
Housing and population density	U.S. Census Bureau (2000)
Water discharge permit records	State Department of Environmental Quality; U.S. EPA (2003)
Land cover	USGS, NLCD (1992, 2001)
Conventional water pollution	EPA National Watershed Characterization (1999)
Hydrologic modification	EPA National Watershed Characterization (1999)
Cities	National Atlas of the United States (2000)
Overall population change	U.S. Census Bureau (1950 -2000)
Change in farmland acreage	U.S. Census of Agriculture (1950 – 1997); State Agriculture Statistics Services
Trends in major dam construction	U.S. Army Corp of Engineers and FEMA, National Inventory of Dams (1996)
Changes in housing density	U.S. Census Bureau, “Profile of Selected Housing Characteristics” (2000)

(modified from Hansen and Gryskiewicz 2003)

NPS Spatial and RS Data

MRLC member – triplicate imagery for 1991, 2001; NLCD products (land cover, impervious surface, canopy; change detection product in future??)

DOQQ for all parks and immediate area (1 quad buffer)

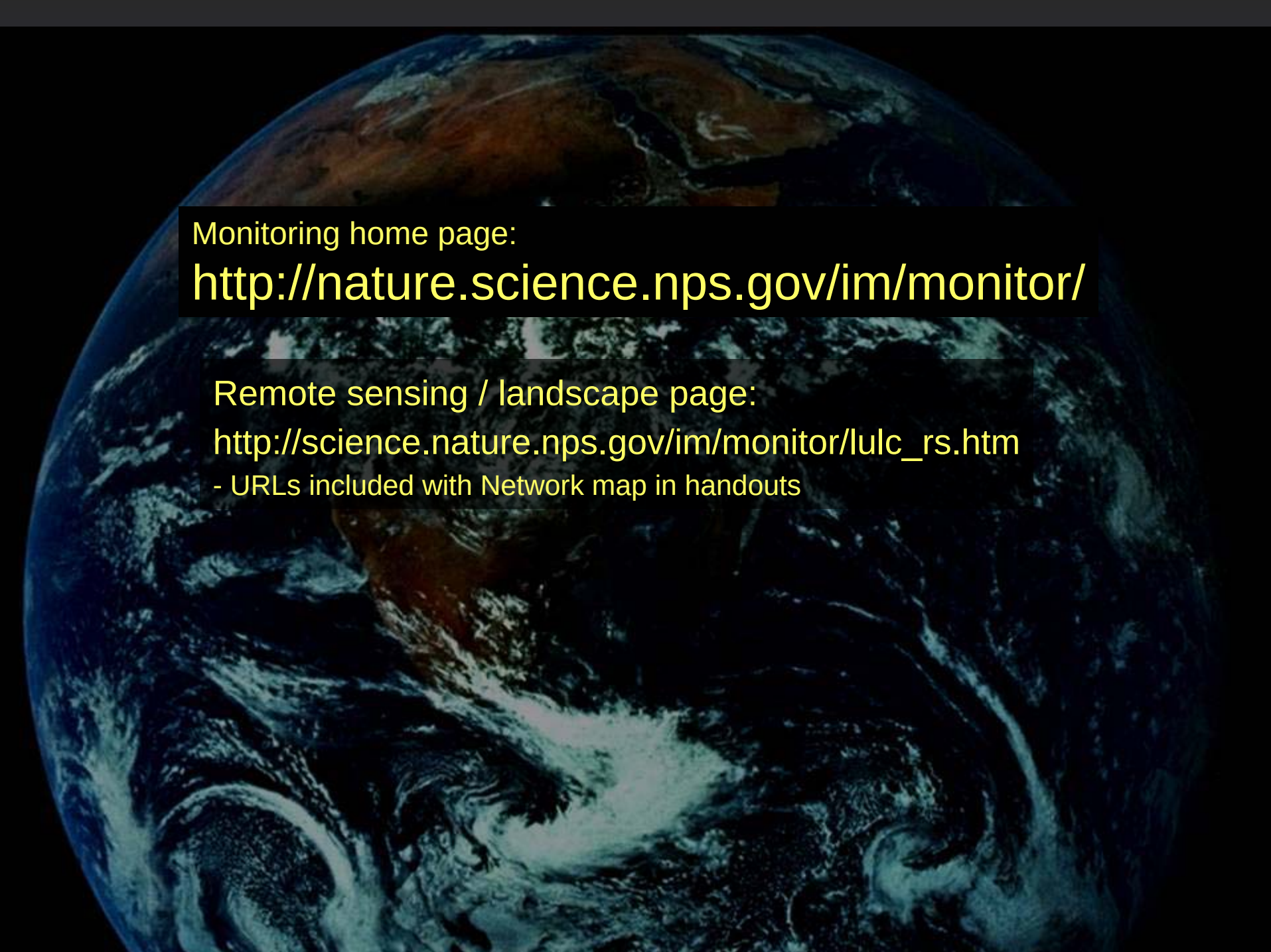
Substantial holdings of imagery by parks

Fire program imagery for fires > 300 ac

Extensive GIS support

Selected I&M Landscape Monitoring Projects

- Detecting change in NW forests: a 3-tiered approach (W. Cohen, R. Kennedy)
- Developing land use change protocol for the GYE (A. Hansen)
- Monitoring landscapes around parks in the National Capitol Region (P. Townsend, R. Gardiner)
- Changing landscapes in the Great Lakes Region (P. Bolstad)
- Using Landsat to estimate land-cover changes in and around 10 parks and 10 segments of the AT (Y.Q. Wang)
- Using RS data to monitor wetland vegetation change (Y.Q. Wang)
- Using LIDAR for coastal change studies (J. Brock)
- Projecting land use changes and impacts on Delaware Water Gap (S. Goetz et al.)
- Using MODIS to monitor land condition (future project in Alaska) (M. White and B. Reed)
- Assessing use of a national roads coverage (R. Watts)



Monitoring home page:

http://nature.science.nps.gov/im/monitor/

Remote sensing / landscape page:

http://science.nature.nps.gov/im/monitor/lulc_rs.htm

- URLs included with Network map in handouts